# Miniaturized Phonon Trap Timing Units for PNT of CubeSats

Completed Technology Project (2015 - 2018)

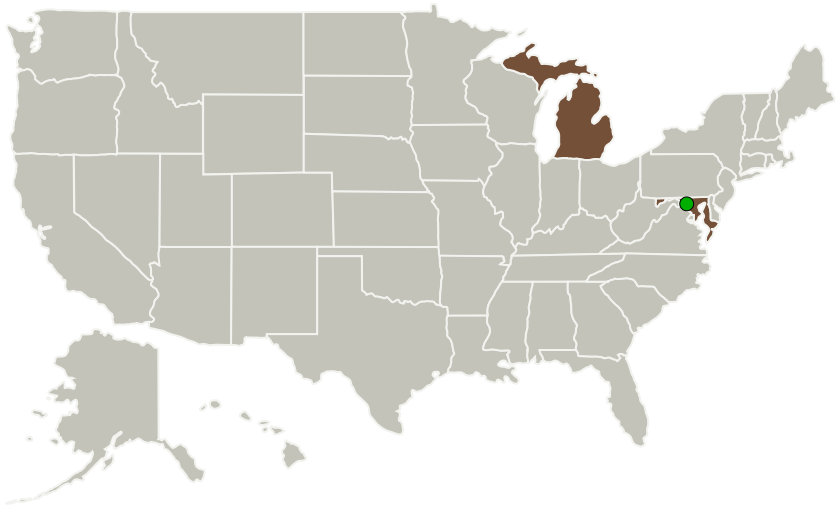
## Project Introduction

This project develops a fast and accurate chip-scale timing unit (clock) that can improve the quantity and quality of data transmitted from small spacecraft. Based on a new generation of phonon traps/resonators that are both passively and actively compensated, the proposed approach tackles these technical challenges by developing a chip-scale all silicon integrated clock that has orders of magnitude better frequency stability, lower acceleration sensitivity, and higher speed compared to quartz-based clock.

## Anticipated Benefits

A high speed and accurate clock vastly improves satellite data transmission rates. A clock with the proposed performance cannot be obtained from any other current or planned product with such small-size, low-weight, low-power, and low-cost, making it an ideal candidate for CubeSats. In addition to CubeSats, precision chip-scale clocks have application in many other DoD systems such as GPS-denied position, navigation, and timing (PNT) as well as in GPS itself.

## Primary U.S. Work Locations and Key Partners

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## Table of Contents

**Small Spacecraft Technology**

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Completed Technology Project (2015 - 2018)

| Organizations Performing Work | Role | Type | Location |
|---|---|---|---|
| University of Michigan-Ann Arbor | Lead Organization | Academia | Ann Arbor, Michigan |
| Goddard Space Flight Center(GSFC) | Supporting Organization | NASA Center | Greenbelt, Maryland |

| Primary U.S. Work Locations | |
|---|---|
| Maryland | Michigan |

## Project Transitions

**October 2015:** Project Start

**June 2018:** Closed out

**Closeout Summary:** Publications: https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20160013215.pdf https://digitalcommons.usu.edu/smallsat/2016/Poster1/16/

## Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html

## Organizational Responsibility

**Responsible Mission Directorate:**

Space Technology Mission Directorate (STMD)

**Lead Organization:**

University of Michigan-Ann Arbor

**Responsible Program:**

Small Spacecraft Technology

## Project Management

**Program Director:**

Christopher E Baker

**Program Manager:**

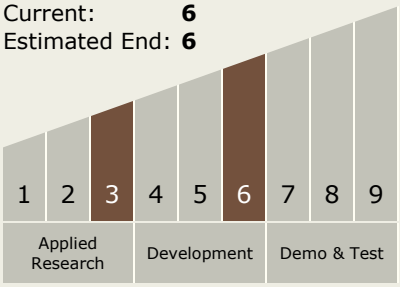
Roger Hunter

**Principal Investigator:**

Mina Rais-zadeh

## Technology Maturity (TRL)

Start: **3**
Current: **6**
Estimated End: **6**



## Target Destination

Earth